WASHINGTON
SCIENCE TRENDS

HIGHLIGHTS

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* NSF SEES FUTURE SCIENCE/ENGINEERING GROWTH

Studies soon to be published by the National Science Foundation predict that the United States will have some 2½ million professional scientists and engineers in 1970, compared to 1.4 million today.

Of these, some 150,000 would be expected to hold doctorate degrees in science and engineering, compared with some 87,000 at the present time.

✓ High Costs -- Educating scientists and engineers which must be added to the work force by 1970 will be expensive. The estimated costs reach $30 billion -- at least one third in facilities and equipment alone.

✓ No Lack of Talent -- There is "no need for science to unbalance our society" according to Foundation officials despite this large-scale program. They estimate that only one-half of one percent of the 1970 population will receive science and engineering doctorates. That's double the present percentage, but only a small proportion of the expected "talent pool" for advanced education.

✓ Soviets Moving Ahead -- Foundation officials have told Congress that at the present time the Soviets are turning out many more "technicians" than the U. S. and are also producing "100,000 plus individuals who are trained beyond secondary schools for an equivalent amount of time to the 4-year engineering graduate in this country, and we are producing less than 40,000 a year at this same level."

* NUCLEAR WEAPONS SAFEGUARDS

The U. S. Air Force has advised the House Military Appropriations Committee that even in wartime nuclear weapons aboard aircraft would not be armed over friendly or neutral territory, while during peacetime flights safety procedures "positively prevent the weapon from being armed or triggered."

The Air Force states:

"There are a series of electrical and manual switches and levers, located in two separate compartments of the bomber aircraft. These switches and levers are kept in the 'off', 'locked' and 'safe' positions at all times, both in the air and on the ground. In addition to the physical off position of these switches and levers, they are safety-wired in the off, locked or safe positions. In order to arm the bomb in the air, two individual crew members in different compartments must energize certain switches simultaneously. This safety factor prevents any one crew member from arbitrarily or unintentionally arming the weapon or permitting the weapon to arm itself if accidently released during a crash..."

Note: Similar precautions and regulations apply to long-range missiles equipped with nuclear warheads.

* POLYESTER FILM BELTS

New studies by the National Aeronautics and Space Administration indicate a wide variety of possible applications for oriented-polyester film belts, such as those which have been used successfully in the Atlas-Score, Vanguard II and Tiros I tape recorders. The belts are fabricated from sheet "Mylar" in thicknesses of ½ to 10 mils.

Some features of this system, which could be applied elsewhere:

✓ Uniform power transmission -- resulting from the exceptionally small variation in belt thicknesses along the perimeter. This all but eliminates the deformation of conventional drives at low temperatures, resulting in speed variations.

✓ High Efficiency -- better than 98 percent efficiencies can be obtained in extremely compact designs. Because of their extreme flexibility and because of the negligible forces required to bend them over a small radii, the only significant power loss in the drive system is that in the bearings due to belt tension.

✓ Other advantages -- including fatigue resistance, high stress tolerance, long life. A unique advantage is the high dielectric strength and surface resistivity of the polyester film material. The advantages of the high surface charge which accumulates were not fully explored -- but in one case the charge was utilized to retain a belt in position, simply by rubbing it against a magnesium driving pulley.

Applications:

High temperature applications are possible, since the film retains useful properties to 150° C. Also, resistance to the action of chemicals, solvents and radiation make these belts attractive in many special applications.

Ultraminiature drive systems are feasible. The ½ mil belts can be applied to shafts as small as 0.040 inch in diameter with a reasonable life. Estimates are that a 1000:1 speed reduction could be accomplished in a ½ inch cube.

Belts have been used in assorted laboratory test devices and machine-shop fabrication set-ups. In one case a 5-mil belt was substituted for a fabric and rubber belt on a 1/12th horsepower, 22,500 rpm tool-post grinder -- with "excellent results."

Servo applications also present possibilities. Applications requiring zero backlash but not perfect registration might benefit from the fluctuation-free drive characteristics. In one case, a reduction of 3600:1 was fitted to a servo motor-synchro combination. Immeasurable backlash was demonstrated, with the aid of a crosshair reflected from a mirror mounted on the low-speed shaft.

Multi-horsepower applications also appear feasible. NASA investigators believe that a belt of 10-mil thickness could be used for applications of 10 horsepower and above where the drive pulley is in the order of 2 inches in diameter, and operates above 3000 rpm.

(Details of research and development, including fabrication techniques, available in NASA Technical Note D-668, J. H. Licht & A. White. Single Copies Free from National Aeronautics and Space Administration, 1520 H Street, N. W., Washington 25, D. C.)

* SURFACE FLAMMABILITY STANDARD: The National Bureau of Standards has available for sale a standard material of prescribed flammability for use in improved methods for measuring the fire-hazard properties of materials.

(Details are available from Standard Sample Clerk, National Bureau of Standards, Washington 25, D. C. A set of four specimens and accompanying certificate with experimental data may be purchased, at $8, from the same source.)

TECHNICAL TRENDS

□ The National Aeronautics and Space Administration Inventions and Contributions Board, Washington 25, D. C. has received some 3,000 to 3,300 ideas for application in the space field during the past 18 months. Of these, 6-10 are being seriously considered for cash awards. √√√ The National Science Foundation, moving rapidly away from its former functions in basic research support, plans to spend $1 million in the next Fiscal Year for "conferences of scientists and mass-media executives" and similar activities. √√√ The Federal Aviation Agency believes that development of light sources that have a high infrared content will result in a visual light system for aircraft that can also serve as a beacon for a self-contained infrared/pilot warning instrument device. √√√ The Air Force's interest in machine tools is shifting from devices for large scale production to high-precision devices for short runs with positive and precise control. Special emphasis will be placed on four-axis and five-axis numerically controlled tools which can cut away or otherwise eliminate more metal from parts without weakening the piece.

□ The National Bureau of Standards, Office of Technical Information, Washington 25, D. C. has available information on its x- and gamma-ray calibration services. √√√ The Strategic Air Command's new system for personnel control was developed by the National Cash Register Co. In addition to speedily locating the most eligible and qualified men for assignments, the system will give SAC planners a daily projection of manpower needs some six months in advance. √√√ NASA has awarded a contract for a prototype radioisotopic method for detecting the presence and monitoring the metabolic activity of microrganisms on an extraterrestrial body. √√√ Announcement NSF 61-131 from the Information Office, National Science Foundation, Washington 25, D. C. lists 56 new grants for development of new laboratory apparatus for science teaching. √√√ A number of advantages are claimed for a new type of antenna composed of a lightweight, rigid foam reflector and an associated positioning device which can move through any angle of azimuth and elevation. Both were developed for the Army Signal Corps by Sylvania Electronic Defense Laboratories, Mountain View, Calif. √√√ The Government Printing Office, Washington 25, D. C. has available (at 20 cents) copies of the new Simplified Practice Recommendation No. R263-60, listing and illustrating the standard stock items of the cemented carbide industry.

□ The Patent Office has been advised that it is "impossible" to hope for hardware capable of meeting its information retrieval needs until certain theoretical problems in the retrieval field are solved. Experts are said to differ as to whether the Patent Office will ever be able to achieve general mechanical patent searching, and there is serious doubt that this can ever be done in the mechanical and electrical arts. √√√ The Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. is negotiating plans for elaborate microfilm files at 12 regional libraries which will receive and make available microfilm of U. S. Government Research Reports. √√√ The Air Force is attempting to eliminate the mailing of its Base Newspapers and Magazines to other than Government personnel and particularly to Foreign Embassies. √√√ Details of revised charges and other changes in the program for "sale" of enriched and depleted uranium are available from the Information Office, U. S. AEC, Washington 25, D. C. in Announcement D-138. √√√ The Navy has quietly let a contract to Chance Vought Corp., Dallas, Tex. for studies of design requirements for satellite launching ship instrumentation, control and range-safety requirements.

□ The Navy's new Experimental Deep Diving Submarine features a novel pressure hull -- a constant diameter cylinder, closed at the ends with hemispherical heads. It is 18 feet in diameter, and is internally framed, using deep frames in the place of structural bulkheads. √√√ Rocketdyne Division of North American Aviation Inc. has received a Navy contract for development of an advanced solid propulsion system for the electronically controlled Sparrow air-to-air missile. √√√ Astronaut Alan Shepard has reported that dust floated in his nominally clean capsule during weightless periods of his recent sub-orbital flight. He proved capable of holding the capsule to within about 5° of the prescribed retroattitude.

RESEARCH CHECKLIST

□ FLUORESCENT X-RAY SPECTOGRAPH: The U. S. Bureau of Mines has disclosed details of its fluorescent x-ray spectograph which can study the surface chemistry of molten metal while it is actually oxidizing at temperatures of 1,650°F. The new instrument uses a resistance-wound electric furnace as a sample holder, bringing the molten surface within a half inch of the x-ray tube window. Bureau officials believe that improvements on this type of device can open up new areas of research in fused salts and molten metals for space technology.

(Details of construction and operation are available in Report of Investigations No. 5739. Single copies free. Send requests to U. S. Bureau of Mines, Publications-Distribution Section, 4800 Forbes Avenue, Pittsburgh 13, Pa.)

□ LOW-ERROR ABLATION RATE SENSORS: A variable-capacitance ablation rate sensor which allows continuous measurements at stagnation temperatures from 2,400° to 3,800°F has been developed by the National Aeronautics and Space Administration. The sensors have been tested in Teflon and similar materials in ethylene-heated high temperature jets at these temperatures. Data readings were telemetered from the test vehicle by flight-proven telemetry equipment of conventional design. The maximum error between material ablation rate as telemetered from the sensor and the rate measured optically during the tests was 4 percent.

(NASA Report TN D-800, "A Sensor for Obtaining Ablation Rates", is available from National Aeronautics and Space Administration, Attn: CODE BID, 1520 H Street, N. W., Washington 25, D. C.)

□ THERMAL VOLTAGE CONVERTERS: The National Bureau of Standards has developed a group of inexpensive thermal voltage converters which are said to be useful for measurements of rms voltages of 1 to 200 volts at frequencies from 3 cps to 30Mc. The Bureau states that by a-c--d-c transfer techniques an accuracy of 0.1 percent or better may be obtained up to at least 10 Mc, and 0.2 percent at 30 Mc. The converters can be used quickly and easily to determine the frequency influence of other rms instruments, as well as for direct a-c measurements.

(Write National Bureau of Standards, Office of Technical Information, Washington 25, D. C. regarding further details of "Accurate R-F Thermal Voltage Converters")

□ MATERIALS TESTING AT 4,000°F: Mechanical testing techniques and equipment which will provide tensile and compressive stress-strain data and shear-strength data up to 4,000°F in a vacuum has been developed by the Battelle Memorial Institute under a contract from the Air Force. Final objective of the work is to extend this capability so that accurate data can be obtained on the mechanical properties of ceramics and other high temperature materials up to 6,000°F. Recommendations have been made by Battelle personnel on furnace design, temperature and strain measurement techniques, and specimen, grip and loading design.

(Details of the successful 4,000°F work and the recommendations for 6,000°F equipment in WADD Technical Report 60-155, available through military channels or at $2.25 from OTS, U. S. Department of Commerce, Washington 25, D. C.)

- SMALL SCALE ROCKET NOZZLE TESTING: Recommended procedures for predicting the performance of full-scale solid propellant rocket nozzle using small scale test data have been outlined in a Battelle Memorial Institute report. It is suggested that small scale tests be separated into three areas of thermal, chemical and mechanical simulation. Simultaneous consideration of these factors can lead to conflicting test requirements and thus the evaluation of a nozzle material may not be accomplished by a single test. Battelle tests have shown that small test rig using a mixture of liquid, gases and powders can produce the proper gas composition and enthalpy for a wide range of possible solid propellants. This inexpensive rig can produce the same mechanism of failure in a test nozzle material as will occur in a full-scale nozzle. It can also produce heat-flux levels of the same magnitude as larger motors.

  (Details of this study and its recommendations are contained in Defense Metals Information Center Memorandum 77 entitled "Rocket-Nozzle Testing and Evaluation" available to Government agencies, contractors, sub-contractors and their suppliers through DMIC, Battelle Memorial Institute, Columbus, Ohio)

- RADIATOR REQUIREMENTS FOR SPACE VEHICLES: Small lightweight radiators are a primary requirement for space vehicles to reduce vehicle structural, orientation and weight penalties. Air Force studies of hypothetical power units and cooling systems show that greater reductions in radiation area can be made by increasing radiator operating temperature than by increasing the thermodynamic efficiency of the machines. Studies covered a wide number of possible heat engine and cooling system combinations from forced vapor cycles to passive systems where natural means of conduction and radiation were employed. A large number of possible refrigerants were investigated. It was concluded that the best way to reduce radiator size in the future is to develop refrigerants with higher performance.

  (WADD Technical Note 60-161, entitled, "Vapor Cycle Cooling Systems for Space Vehicles" is available through military channels or at 75 cents from OTS, U.S. Department of Commerce, Washington 25, D. C.)

- NEW ANTENNA ARRAY: The National Bureau of Standards has designed an oblique incidence receiving antenna array. Although specifically used for a relative ionospheric opacity meter installed in Alaska, the Bureau suggests that the design could also be of value for single channel high-band TV reception, and communication antennas where only a single frequency of transmission is used and the bandwidth is sufficient. While the antenna, as designed, is for receiving purposes only, it is also useable as a transmitting antenna type.

  (Details available. 7 Pages. 50 Cents. Write OTS, U. S. Department of Commerce, Washington 25, D. C. for NBS Technical Note No. 78, PB 161 579)

- STEEL MIRRORS: Air Force development of an ultra-high speed streak camera has proven the feasibility of producing small ferromagnetic prisms whose faces are optically flat mirrors. It was found that certain types of steels can be successfully ground and polished using standard optical equipment and techniques. A heat treatable stainless steel proved to be the most satisfactory of those tested.

  (Details reported in WADD Technical Note 60-155((PB 171 191))available through military channels or at 50 cents from OTS, U. S. Department of Commerce, Washington 25, D. C.)

PUBLICATION CHECKLIST

- NEW PLUTONIUM PRODUCTION REACTOR, contains all of the unclassified studies on generating byproduct electrical energy with the New Production Reactor (NPR) under construction at Hanford, Wash. a program recently endorsed by the White House. 375 Pages. Single Copies Free. (Write Joint Committee on Atomic Energy, F-88, The Capitol, Washington 25, D. C. for "Power Conversion Studies, Hanford NPR")

- TRANSFORMATION OF RECTANGULAR SPACE COORDINATES, a technical paper compiling and explaining various principles of geodesy for missile and space scientists whose duties may require fixing the positions of points not lying on the earth's surface. 13 Pages. 15 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Coast and Geodetic Survey Technical Bulletin No. 15)

- RECENT DEVELOPMENTS IN COLUMBIUM AND TANTALUM TECHNOLOGY, a review of major developments in the technology of these metals and their alloys. 5 Pages. (Available at no cost to Government agencies, their contractors, subcontractors and suppliers. Ask Defense Metals Information Center, Battle Memorial Institute, Columbus 1, Ohio for DMIC Memorandum No. 97)

- CERAMIC FUELS, a 1960 report, now available on various novel approaches to nuclear reactor fuel elements, with emphasis on non-sintered ceramic fuels. Prepared by the staff of the Hanford Atomic Products Operations, Richland, Wash. for the AEC. 54 Pages. (Report HW 64629 available through AEC channels or at $1.25 from OTS, U. S. Department of Commerce, Washington 25, D. C.)

- SYNTHETIC RUBBER PRODUCTION, a preliminary report showing that U. S. production of elastomers (synthetic rubbers) was slightly higher in 1960 than in 1959. Single Copies Free. (Write Public Information Office, U. S. Tariff Commission for "Preliminary Report on Elastomers")

- LEGAL PROBLEMS OF SPACE EXPLORATION, a massive "symposium" prepared by the Library of Congress, containing selected articles from a variety of sources on these complex problems. 1392 Pages. (Write Committee on Aeronautical and Space Sciences, U. S. Senate, Washington, D. C. regarding Senate Document No. 20, "Legal Problems of Space Exploration")

- JOINT COMMITTEE ON ATOMIC ENERGY, a compilation of information on this important Congressional Group. 31 Pages. Single Copies Free. (Write Mr. James T. Ramey, Executive Director, Joint Committee on Atomic Energy, F-88, The Capitol, Washington 25, D. C. for "Membership, Publications and Other Pertient Information, JCAE")

- SOVIET EXTRUSION MANUAL, a U. S. translation of the only complete work on the extrusion of metals compiled by the Russians. Describes technology, design of equipment, assembly and operation, etc. 650 Pages. $8. (Write OTS, U. S. Department of Commerce, Washington 25, D. C. for Publication 60-21264, "The Extrusion of Metals")

- NUCLEAR FUELS AND MATERIALS DEVELOPMENT, an Atomic Energy Commission survey of work being done in a number of laboratories to increase the knowledge of and effect improvements in reactor materials. 171 Pages. (Report TID 11295 available through AEC channels or at $2.75 from OTS, U. S. Department of Commerce, Washington 25, D. C.

- UNITS OF WEIGHTS AND MEASURE, a review of the units of length, area, volume, capacity and mass in the U. S., and tables of interrelation and equivalents for these units in the metric system. 62 Pages. 40 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Publication No. C13.10:233)